X050994

UNIVERSITY OF NORTH CAROLINA AT CHARLOTTE

Department of Electrical Engineering

Experiment No.________Types of Voltmeters

INTRODUCTION

There are various types of voltmeters in use today. It is important that one know which type one is using and its limitations in order that correct measurements be obtained. For instance, an instrument may measure direct-current voltage (VDC), alternating-current voltage (VAC or AC RMS), VAC plus VDC (VRMS or true RMS), peak-to-peak voltage (Vp-p), maximum voltage (Vp), or any combination of these. A DC measuring instrument would not measure AC signals accurately nor would an AC measuring instrument always measure true RMS. Also, all AC measuring instruments have some frequency range over which they will measure AC signals accurately.

$$\mathrm{VDC} = \frac{1}{T}\int_0^T v(t)\,dt \qquad \text{(or average value)}$$

$$\mathrm{VRMS} = \sqrt{\frac{1}{T}\int_0^T [v(t)]^2\,dt} = \sqrt{(\mathrm{VDC})^2 + (\mathrm{VAC})^2}$$

where T is the time period of one complete cycle. VAC can be obtained from the last equation.

$$\mathrm{VAC} = \sqrt{(\mathrm{VRMS})^2 - (\mathrm{VDC})^2}$$

It is seen above that VAC = VRMS if VDC is zero. Also, all of what has been stated above for voltmeters could apply to ammeters.

The purpose of this experiment is to have the student measure the VDC, VAC, VRMS, and Vp-p magnitudes of various waveforms with several different types of voltmeters and compare them with calculated values. Also, the frequency response of each voltmeter will be determined.

PRELIMINARY

P-1. Calculate the VDC, VRMS, and VAC for the voltage waveforms given in Figure l.

Square-wave:

VDC = _______________; VRMS = ______________; VAC = ______________.

P-1. (Continued)

Triangular-wave:

VDC = ________________; VRMS = _______________; VAC = _______________.

P-1. (Continued)

Sine-wave:

VDC = ________________; VRMS = _______________; VAC = _______________.

P-1. (Continued)

Ramp-wave:

VDC = ________________; VRMS = _______________; VAC = _______________.

P-1. (Continued)

Pure Sine-wave:

VDC = _________________; VRMS = ________________; VAC = ________________.

P-2. The AC scale readings of the Knight Model KG625 VTVM and Micronta Model 22-204U VOM are related to their input voltage by the following relationship.

$$VAC = K_k\ V(\text{peak-to-peak}) \text{ for the Knight VTVM}$$

$$VAC = K_m\ V(\text{half-wave average}) \text{ for the Micronta VOM}$$

Determine the values of Kk and Km (refer to the VOLTMETER DATA sheet).

Kk = ______________________________; Km = _________________________________.

P-3. Determine the VAC scale readings of the Knight VTVM and Micronta VOM for the waveforms in Figure 1 using the relationships in P-2 above.

	Knight VTVM	Micronta VOM
Square-wave	__________ V	___________ V
Triangular-wave	__________ V	___________ V
Sine-wave	__________ V	___________ V
Ramp-wave	__________ V	___________ V
Pure Sine-wave	__________ V	___________ V

P-4. Explain how the polarity of the input to the Micronta VOM could make a difference when measuring VAC.

(INSTRUCTOR'S SIGNATURE__________________________DATE___________)

PROCEDURE

L-1. Using a function generator, apply a 1000 Hz, +10-0 volt square-wave signal to the oscilloscope. Make sure the vertical vernier on the oscilloscope is in calibrate, the input on DC input, and a zero-volt reference established. Make the measurements indicated on Data Sheet #1 using the indicated voltmeters. WATCH THE PROBE SETTINGS!!

L-2. Repeat Procedure L-1 above for the triangular-wave, sine-wave, and ramp-wave.

L-3. Using a sine-wave generator, repeat Procedure L-1 above for a+5-5 volt pure sine-wave. Put the information on Data Sheet #2.

L-4. Using a sine-wave generator, apply a 1000 Hz, 5-volt RMS signalto the first voltmeter on Data Sheet #3. LEAVE THE OUTPUT MAGNITUDE OF THE SINE-WAVE GENERATOR SET AT THIS VALUE. Now vary the frequency of the sine-wave generator as indicated on Data Sheet #3 and note the reading of the voltmeter.

> The frequency of the signal generator (HP Model CD200) can best be varied by setting the vernier control on the desired number and switching the multiplier control up and down.

L-5. Repeat Procedure L-4 above for the remaining voltmeters.

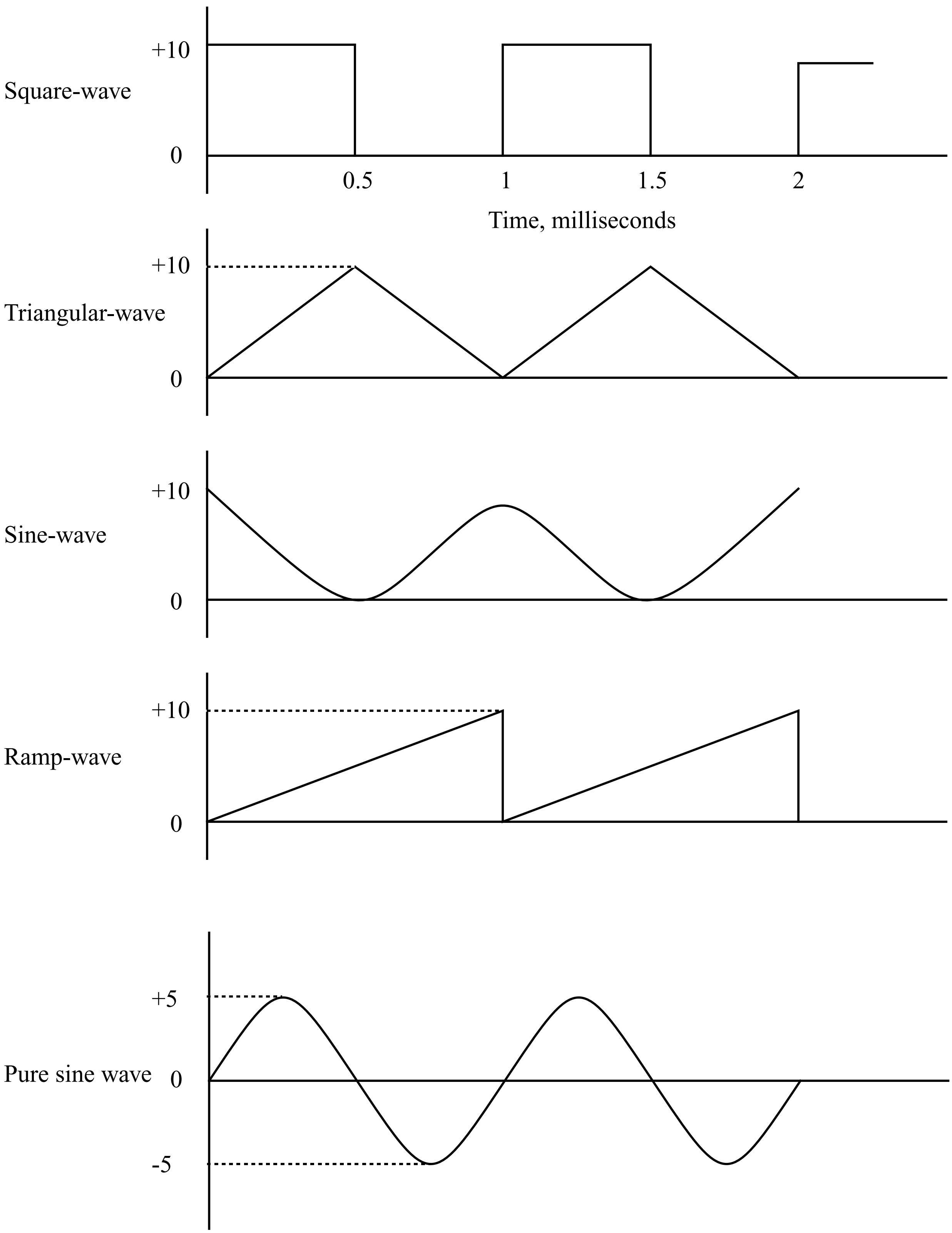
REPORT

R-1. Compare the measured voltmeter readings with the calculated values.

R-2. Compare the measured values of VAC obtained with the Knight VTVM and Micronta VOM with calculated values from P-3 above.

R-3. Discuss under what conditions each voltmeter may be properly used.

R-4. Rate each voltmeter as to its frequency response.



+10
Square-wave
0
0.5
1
1.5
2
Time, milliseconds
+10
Triangular-wave
0
+10
Sine-wave
0
+10
Ramp-wave
0
+5
Pure sine wave
0
-5

Figure 1.

VOLTMETER DATA

Knight Model KG625 VTVM

a. It is a vacuum-tube voltmeter and must have external AC power to operate.
b. The common lead is at AC ground and, therefore, care must be exercised when using the voltmeter in a circuit.
c. It measures the average value of any waveform when on DC.
d. It measures the peak-to-peak value of any waveform when on AC. The face is scaled to read AC RMS of a pure sine wave when on AC.
e. It uses a d'Arsonval meter movement.
f. The input impedance is eleven megaohms.

Micronta Model 22-204U VOM

a. It does not need external power to operate. It operates on internal batteries when measuring resistance.
b. The common lead can be placed anywhere in a circuit since it would not be at AC ground.
c. It measures the average value of any waveform when on DC.
d. It measures the average value of the positive portion of any waveform (or negative portion depending on how the measurement is made) when on AC. The face of the meter is scaled to read AC RMS of a pure sine wave.
e. It uses a d'Arsonval meter movement.
f. The input impedance is 5,000 ohms/volt when on DC and 10,000 ohms/volt when on AC. (For instance, if the meter were set on the 10-volt scale, the input impedance would be 50,000 ohms on DC and 100,000 ohms on AC).

Hewlett-Packard Model 3466A VOM

a. It is a digital, auto-ranging volt-ohmmeter that will operate either from external AC power or from an internal battery pack. The internal batteries are trickled-charged as long as the device is connected to external power. The switch to battery power is automatic whenever external power is removed.
b. The common lead is at AC ground whenever external power is being used and care must be exercised when using the voltmeter in a circuit. When battery power is being used, the common lead can be placed anywhere in a circuit.
c. It measures DC, AC RMS, and true RMS (AC + DC) of any waveform that is within the crest-factor limitations of the device.

DATA SHEET #1

BE SURE TO CHECK AND RECHECK THE PROBE ON THE KNIGHT VTVM!!

	MEASURED				CALCULATED		
SQUARE-WAVE	Vp-p	VDC	VAC	VRMS	VDC	VAC	VRMS
Oscilloscope	+10-0 V	XXXXX	XXXXX	XXXXX			
Knight VTVM				XXXXX			
Micronta VOM	XXXXX			XXXXX			
HP Model 3266A	XXXXX						

BE SURE TO CHECK AND RECHECK THE PROBE ON THE KNIGHT VTVM!!

	MEASURED				CALCULATED		
TRIANGULAR-WAVE	Vp-p	VDC	VAC	VRMS	VDC	VAC	VRMS
Oscilloscope	+10-0 V	XXXXX	XXXXX	XXXXX			
Knight VTVM				XXXXX			
Micronta VOM	XXXXX			XXXXX			
HP Model 3266A	XXXXX						

BE SURE TO CHECK AND RECHECK THE PROBE ON THE KNIGHT VTVM!!

	MEASURED				CALCULATED		
SINE-WAVE	Vp-p	VDC	VAC	VRMS	VDC	VAC	VRMS
Oscilloscope	+10-0 V	XXXXX	XXXXX	XXXXX			
Knight VTVM				XXXXX			
Micronta VOM	XXXXX			XXXXX			
HP Model 3266A	XXXXX						

DATA SHEET #1 (Continued)

BE SURE TO CHECK AND RECHECK THE PROBE ON THE KNIGHT VTVM!!

	MEASURED				CALCULATED		
RAMP--WAVE	Vp-p	VDC	VAC	VRMS	VDC	VAC	VRMS
Oscilloscope	+10-0 V	XXXXX	XXXXX	XXXXX			
Knight VTVM				XXXXX			
Micronta VOM	XXXXX			XXXXX			
HP Model 3266A	XXXXX						

DATA SHEET #2

BE SURE TO CHECK AND RECHECK THE PROBE ON THE KNIGHT VTVM!!

	MEASURED				CALCULATED		
PURE SINE-WAVE	Vp-p	VDC	VAC	VRMS	VDC	VAC	VRMS
Oscilloscope	+5-5V	XXXXX	XXXXX	XXXXX			
Knight VTVM				XXXXX			
Micronta VOM	XXXXX			XXXXX			
HP Model 3266A	XXXXX						

DATA SHEET #3

BE SURE TO CHECK AND RECHECK THE PROBE ON THE KNIGHT VTVM!!

	Frequency (Hertz)							
	5	10	22	50	100	220	500	1000
Knight VTVM								5 V
Micronta VOM								5 V
HP 3466A								5 V

BE SURE TO CHECK AND RECHECK THE PROBE ON THE KNIGHT VTVM!!

	Frequency (Hertz)							
	1000	2200	5000	10000	22000	50000	100000	220000
Knight VTVM	5 V							
Micronta VOM	5 V							
HP 3466A	5 V							